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THE USE OF STRAINED MEATS AS THE PROTEIN BASIS FOR MILK SUBSTITUTES IN THE TREATMENT OF MILK ALLERGY

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IT HAS been pointed out by Hill and Stuart[1] that the only food substances, other than animal milk, providing in suitable concentration all the amino acids specifically needed by an infant for continued normal nutrition are the animal meats and the soybean. Human breast milk would appear to be an ideal preparation for infants sensitive to cow's milk. While it is possible that sensitivity to human breast milk may occur in infancy,[2, 3] such cases are exceedingly rare. The chief difficulties with the use of human breast milk are that it is not always readily available, is not always produced by mothers on the proper diet for a particular allergic infant, and that, when it must be purchased, it is usually quite expensive.

The introduction of a relatively inexpensive and universally available soybean milk by Hill and Stuart[1] in 1929, and the various soybean milks which have been developed have been of tremendous assistance in the care of infants sensitive to cow's milk. However, an occasional infant is found who is also sensitive to soybean milk. These infants are now rare, but with the tremendous increase in the use of the soybean as an article of diet and as a basis for plastics, sensitivity to soybean will surely become more and more common as time passes on. Other substitute milks have been brought forward which for the most part have as their basis carbohydrate foods.[4] The fact that nutritional edema may result from the use of such preparations is illustrated by Case 3 of this article. In infants over 3 months of age who have good appetites and will eat well from a spoon, nutritional deficiencies may easily be made up by the feeding of a variety of semisolid foods. In the case of infants under this age who suffer from allergic manifestations, principally colic, constipation, diarrhea, and eczema, the necessary constituents of the diet are best provided either in solution, or in suspension, in a suitable liquid substitute for milk. There have been many other substitutes for cow's milk which have been used with varying

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success, such as almond and other nut milks and poppy-seed milk.[5] None of these have proved completely satisfactory.

Hydrolized casein[6] should, theoretically, provide a satisfactory milk substitute, at least for short intervals. In my experience, its use has been disappointing. Diarrhea occurs easily with this preparation and milk-sensitive babies do not commonly respond favorably. Perhaps the reason is that infants may be so exquisitely sensitive to milk protein that they will react to it even when present in such minute traces that it cannot be detected by the usual chemical or biologic tests. That the latter is possible is indicated by the work of Ratner and Gruehl[7] and Ratner[8] on so-called allergenically denatured diets. For example Ratner was unable to shock guinea pigs consistently by the injection of Pablum extract and therefore called this cereal mixture a completely denatured food which should be harmless in allergic individuals. However, practically every pediatrician has had experience with infants who developed eczema due to some one of the constituents of Pablum, particularly wheat.

The third class of foods, animal meat, has not been thoroughly studied as to suitability for use in milk substitutes. The use of animal meat in such substitutes is not new. Rowe,[9] in 1931, published formulas using beef and lamb meat juice in milk substitutes. Cohen, Wallace, Mallory, and Rudolph,[10] in 1933, described a milk substitute in which beef is used as the principal source of protein, with other substances added to round out the formula. My personal experience with this preparation has been unfavorable, but it has been successfully used by others and does have a useful place in the armamentarium of the pediatric allergist. The formula contains several substances to which infants are easily sensitized and has the great disadvantage of rigidity. At the author's suggestion, Landau[11] in 1935 prepared and successfully used, in the treatment of eczema, a milk substitute whose basis was thoroughly dried beef muscle from which the fat had been extracted by ether, and the material then ground into a fine powder and rubbed through a fine sieve, similar to the way in which beef is prepared in the powdered form for use in scratch testing. Although we were successful, we were forced to give up this particular method of making a milk substitute because of the time and labor involved. I did not experiment further with meat as the basis for substitute milk until Rowe,[12] in 1941, mentioned homogenized lamb, beef, and beef liver, and suggested their use in such formulas.*

The method of preparation is as follows. The meat is cut into small pieces, and placed in glass-lined kettles to which a small amount of water is added to prevent adhesion of the meat to the kettle. A small amount of salt is added at this point. The meat is then thoroughly, rapidly, and uniformly cooked in an atmosphere of live steam. It is

*These meats were prepared by Harold H. Clapp, Inc., of Rochester, New York, at the suggestion of Dr. Rowe, and under the direction of Dr. Richard A. Reinecke, of the Research Department of that company. These preparations will not be available commercially until after the war.

then passed through a comminuting or straining machine in which a number of blades or paddles are revolving in a cylinder of stainless steel which is perforated throughout, the diameter of each perforation being 1.44 mm. (0.06 inch). The meat is retained in the cylinder and acted upon by the blades until it is sufficiently divided so that it will pass through the 1.44 mm. perforations in the stainless steel cylinder. The meat, when passed through this operation, is technically in a thoroughly homogeneous condition.

The strained meat, together with the broth, is pumped through stainless steel tubing to a glass-lined holding kettle where the product is automatically passed, by stainless steel fillers, into clean, washed jars. The caps are automatically applied to the jars in a tunnel of live steam which replaces the air from the head space, resulting in a highly vacuumized package. The jars are then placed in large steam cookers and sterilized at a temperature of 240° F. In this process the product is rendered completely sterile, making it absolutely safe for use in feeding infants, children, and patients requiring special diets. After completion of the sterilization process, the jars are promptly cooled, and are ready for labeling and casing.

Since these meats are referred to by Rowe[12] as homogenized meats, the question will naturally arise as to whether or not they are homogenized in the sense that milk is homogenized, since that is the one homogenized product with which the pediatrician as well as the public is particularly familiar. In considering this, two different meanings of the phrase "as milk is homogenized" must be considered. In referring to the homogenization of milk, the reference may be directed toward the property of a stable, oil-in-water emulsion producing a completely homogeneous substance. Immediately after the meat is put through the perforated stainless steel cylinder in the manner previously described, it is, technically, thoroughly homogenized. The high temperature of the subsequent sterilization process, however, results in some separation of the fat from the meat, destroying, to a degree, the completely homogenous condition which exists previous to sterilization.

If, in referring to the homogenization of the strained meat as compared with the homogenization of milk, the reference is directed to the particle size in the strained meats, the size of the fat globules in homogenized milk is much smaller than the particle size in the strained meat. In this sense the strained meats cannot be considered to be homogenized in the same sense that milk is homogenized. Therefore it would appear that although these meats in one stage of their process are homogenized from the view point of the food technologist, in the final state they are not, so that it is more accurate to refer to these products as strained or finely divided meats rather than as homogenized meats.

These meats are fine enough so that, when undiluted with water at a temperature of 37.5° C. (100° F.), they will pass through a tube

TABLE I

STRAINED MEATS (ROWE) USED FOR COW'S MILK FORMULA SUBSTITUTES

	WEIGHT (GM.)	MEASURE	CHO	PROTEIN (GM.)	FAT (GM.)	CALORIES	Ca (GM.)	P (GM.)	Fe (GM.)	CL AS NaCL
Strained lamb P—12.23 per cent F—11.17 per cent	270	1⅛ cups	--	33	30	402	0.11	2.07	.015	
Strained beef P—10.74 per cent F—10.07 per cent	307	1¼ cups	--	33	30	402				
Sesame or soy oil	10	2½ tsps.	--	--	10	90				
Sugar (cane or beet)	30	2⅔ tbsp.	30	--	--	120				
Potato starch flour 83 per cent CHO or	24	2⅓ tbsp.	20	--	--	80				
Tapioca flour 88 per cent CHO	23	2⅓ tbsp.	20	--	--	80				
Calcium carbonate 40 per cent Ca	3	1 tsp.	--	--	--	--	1.20	--	--	--
Sodium chloride	1.75	½ tsp.	--	--	--	--	--	--	--	1.75
Water q.s. to 1,000 c.c.		4¼ cups								
TOTAL FOR 1,000 c.c.			50	33	40	692	1.31	2.07	.015	1.75
or for 100 c.c. (per cent)			5	3.3	4.0	69.2	0.13	0.20	.0015	0.175
The above formula compared with										
Whole cow's milk (Sherman and Bridges)			5	3.3	4.0	69	0.12	0.09	.0002	0.175
Human milk (Bridges)			6.5	1.5	3.3	61.7	0.04	0.01	.0001	0.058

Method of preparation—All measurements are level, using standard measuring cups and spoons. Heat water to boiling in the top of a double boiler. Add sugar, salt, and calcium carbonate. Mix the potato starch or tapioca flour to a paste in 1/3 cup of cold water and stir into the boiling water. Cook for forty-five minutes in a double boiler stirring occasionally to prevent lumping. If necessary, add water to allow for evaporation. Add the strained meat and oil, mix thoroughly and reheat.

Albert H. Rowe, M.D.: To be published.

3 mm. (0.125 inch) in diameter under a hydrostatic head of not more than 5 cm. (2 inches) of the product, provided that the product is stirred to prevent separation of the broth from the more solid portions. This means that they may be fed to patients through a fairly small catheter, a fact which should be of considerable interest to dieticians who must devise for some patients a high protein diet with low bulk. A practical example of this might be for use in feeding cases of jaw injury where it is necessary to keep jaws wired together for any length of time. The meats have also proved extremely useful in the feeding of normal infants.

The formula for the preparation of the milk substitute by using the finely divided or strained meats as a base is shown in Table I, with which Dr. Rowe was kind enough to provide me. I chose lamb as the meat base rather than beef because it has been shown by Ratner and Gruehl[13] that milk can sensitize to bovine serum in experimental animals, and it would be present in the beef muscle. The use of lamb obviates any controversy regarding this question.

From Table I it is evident that such a formula has a wide range of flexibility. Any available animal meat could be used as a basis. Horse meat should be particularly inexpensive and practical for this purpose. Instead of sesame oil, other oils such as corn, olive, etc., could be used. Instead of potato or tapioca flour, many other carbohydrates are available.

One curious effect of the meat milk substitute is that, in the course of four to six weeks' use, the rubber nipples swell to twice their normal size. This is probably due to the action of the fat upon the rubber.

The following three cases are reported as illustrating the successful use of strained meats as the protein basis for milk substitutes in the treatment of milk allergy in infants.

CASE REPORTS

CASE 1.—J. H. L. This boy was first seen at the office, at the age of 9 months, for treatment of eczema. This had started at the age of 3 months, at which time breast nursing, which had been only partial, was completely stopped. Various forms of cow's milk had been employed without relief. He had never been on a milk-free diet. Experience had shown that he could tolerate neither tomato nor Pablum. Environmental control was instituted, and he was placed on a trial diet of soybean milk, taro flour, and crystalline ascorbic acid.

On this regimen, the skin became less oozy and some of the redness disappeared, but the improvement was not striking. Direct testing could not be done because of the universal involvement of the patient's skin. Passive transfer was employed, using both the mother and the father as recipients. All tests were negative. Instead of soybean milk, the boy was then put on the lamb meat milk substitute, using corn oil instead of sesame oil and taro flour (poyo meal) instead of potato

or tapioca starch. Improvement was marked within twenty-four hours and was steadily progressive. When the skin had cleared satisfactorily, it was found by the method of progressive addition of foods that the following agreed with the patient: beet, carrot, chicken (capon), corn, molasses, oatmeal, white potato, Ry-Krisp wafers, and cream of rye cereal. Vitamin C was supplied by means of crystalline ascorbic acid and vitamin D by means of drisdol. These foods were shown to disagree: cow's milk, beef, string bean, soybean, Jello, and pear. Within eight weeks the boy's skin was in almost perfect condition. At the age of 19 months he was successfully and uneventfully vaccinated against smallpox. At the age of 2 years the introduction of milk products, starting with cottage cheese was tried, but had to be discontinued because the eczema recurred.

CASE 2.—D. R. S. This boy was first seen at the age of 4½ months. His eczema apparently started when he was about 1 week old and became progressively worse, despite various changes of cow's milk formulas and goat's milk on which, incidentally, he did worse than on cow's milk. Soybean milk caused slight but not striking improvement. Scratch tests were positive for barley, corn, lactalbumin, oat, pea, and wheat. Egg white gave a delayed positive reaction. At the age of 6 months, in addition to eczema he developed allergic rhinitis as evidenced by the clinical appearance of his nasal mucous membranes and a smear of the nasal secretions which was positive for eosinophiles. At the age of 9 months he had an asthmatic attack. A taro milk formula[14] was tried without relief. He was put on lamb meat milk, and on this he did very well. It was found that he could not tolerate any of the green vegetables, but could tolerate white potato and beet. On this very limited diet plus crystalline ascorbic acid and drisdol he did very nicely and by the time he was 11 months old his skin was quite clear. He was continued on the lamb meat milk until he was about 16 months old at which time he had developed a considerable tolerance for cow's milk and other foods.

CASE 3.—S. L. C. This child was first seen in the Allergy Clinic of Genesee Hospital at the age of 4 months. The child had been breast fed for three weeks and then placed on an evaporated milk formula. Eczema started on the face at that time and soon became severe and generalized. She was admitted to the hospital and direct skin testing with the indicated allergens was negative. She was placed on a diet of Mull-Soy, Drisdol, and crystalline ascorbic acid without relief. Substituting a hydrolized casein mixture for the Mull-Soy did not help and the child developed a severe diarrhea. She was then placed on a taro milk formula[14] and was discharged with a clear skin fourteen days later. It was found that she could tolerate carrots and bananas and ground liver, which was added to increase the protein intake. Three weeks later, she was readmitted because of a severe generalized

edema. The eczema had also recurred because, as was later demonstrated, a cereal containing powdered milk (Cream of Rice) had been added to the diet. The urinary findings and blood chemistry were normal, except that her total serum proteins were 4.2 (normal for age about 6.3) with reversal of the albumin-globulin ratio (albumin 2, globulin 2.2). An analysis of her diet showed that her daily intake of protein had been 20 Gm. whereas the theoretical optimum was 25 Gm. She was put on the meat milks (all of which she tolerated) and made a good recovery. She was discharged on the taro milk plus added protein, because the supply of strained meat for milk was at its end. However, after a few weeks at home, the edema recurred and she is now being kept in the hospital where her serum proteins are being kept up by injections of plasma and she is gradually being taught to eat the less finely ground meats. This is necessary because the child is a poor eater who will not take meats readily unless finely strained as in the meat milk substitutes.

In search of a complete protein food for newborn infants, that is readily available and at least theoretically of a nonallergic nature, it occurred to me that such food might be made by using the human red blood cells now discarded in such large amounts in the processing of plasma for emergency use. Red blood cells consist largely of hemoglobin which is deficient in several essential amino acids and it was my thought that these acids might be added in the process of manufacture of the milk substitute. This problem was suggested to Dr. Earl L. Burbidge,* who felt that this was probably impractical.

Human plasma or serum would probably be suitable for adaptation as protein bases for artificial milks, but at the present time the demands of war preclude their consideration for that purpose. Theoretically, the perfect meat base for an artificial milk would be human muscle tissue.

SUMMARY

1. The use of specially strained meat as a protein basis for milk substitutes in the manner described by Rowe is discussed.

2. Three case reports, illustrative of the successful use of such substitutes, are presented.

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DISCUSSION

DR. BRET RATNER.—Dr. Glaser's attempt to create a substitute for milk in the treatment of the milk allergic case is commendable, for the problem of milk allergy is still regarded as a puzzling one. Many efforts have been made to provide a substitute for this all-important food, which Dr. Glaser has enumerated, but somehow none of them seem to withstand the test of time. The possible explanations for these failures may be considered in three categories: (1) Milk is so uniquely important a food product in childhood, that depriving the child of it for any length of time appears to endanger nutritional balance. (2) Milk is a component of so many foods as to make it difficult to eliminate it entirely from the child's diet. (3) Milk sensitive patients, particularly those suffering from eczema, are usually sensitive not alone to milk but other substances as well. It must be recalled that environmental contacts do play a large role in the infantile eczema case. This last is probably the most important reason for failure with a milk substitute alone.

In my own experience I have found evaporated milk very effective in the treatment of the milk sensitive child. An increasing number of babies are being fed this modification of raw milk, which may be attributed to a recognition of its qualities. The overwhelming majority of babies sensitive to milk are sensitive to the lactalbumin and lactoglobulin fractions. Only a few are sensitive to the casein fraction. Most of these so-called casein cases are exquisitely sensitive to the lactalbumin intimately associated with the casein. In so far as the casein is coagulated in the stomach by pepsin and hydrochloric acid, the only allergens passing the pylorus are the albumin and globulin fractions contained in the whey. Only albumins in a highly soluble form can pass through the intestinal wall and circulate as active allergens. When milk is homogenized and subjected to heat, the albumin fractions become coagulated and cannot, therefore, act as allergens. For this reason in evaporated milk, in which allergens are coagulated, we have an ideal form of allergenically denatured food.

The problem of milk sensitivity, it would seem to me, resolves itself not in seeking new substitutes for milk, but rather into: (a) the judicious use of a heat-denaturized form of milk, of which evaporated milk is an excellent example; (b) the discovery of additional allergenic factors in a case, other than milk sensitivity, and their correction; (c) the treatment of secondary infections superimposed on the original eczema; (d) the correction of existing constitutional dysfunctions, e.g., hypothyroidism.